The Osborn Engineering Co.
Cleveland, Ohio.

General specifications for Electric railway bridge superstructures

SPECIFICATIONS

FOR_____ BRIDGE _____

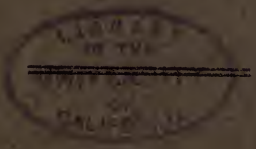
AT _____

FOR _____

GENERAL SPECIFICATIONS

FOR

Electric Railway Bridge Superstructures.



THE OSBORN ENGINEERING CO
OSBORN BUILDING.
CLEVELAND, - OHIO.

1903.

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SPECIFICATIONS.

FOR .....BRIDGE OVER.....

at.....

The engineer's general drawings consist of:—

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....

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....

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....

....

....

.....

The Superstructure will consist of .....spans.....long.

.....

Live load to be..... .....

....

....

Paint "first coat" to be .....

.....''finish coats'' to be..... ...

Contractor to erect..... .....

....

.....

The entire work to be completed on or before.....19.....

Traffic to be maintained.....

....

Old Structure to be removed..... .....

.....

Contractor to furnish falsework timber.....

" " " *and place wooden floor.....*

GENERAL SPECIFICATIONS

FOR

Electric Railway Bridge Superstructures

THE OSBORN ENGINEERING COMPANY
Osborn Building. Cleveland, O.

1903.

I. CLEARANCE.

1. On a straight track a section, as per diagram given in appendix, must be kept clear in single track through bridges. On a curved track and in double track structures the clear width must be proportionately increased. The distance center to center of the double track is 13 feet. Assuming length of cars 75 feet and spacing of trucks 54 feet, center to center, 2½ inches additional clear width must be provided on the inside of curves for every inch of elevation of outer rail, on account of tipping of cars. The width from center to center of trusses shall not be less than 1-20th of the span.

See Appendix A.

II. DRAWINGS.

Engineer's General Drawings.

2. Accompanying these specifications, and forming a part hereof, are general drawings, as enumerated on the second page of these specifications, embodying the information and data furnished the contractor for his guidance.

Contractor's General Drawings.

3. If general drawings are submitted by the contractor with his proposal, they shall include all stress sheets giving the lengths of spans from center to center of chords; the width of the bridge in the clear and from center to center

of trusses; the dead, live and other loads on which calculations are based; the dead, live and other load stresses as well as the minimum stresses, and sections for all members; the sections and areas of lateral and portal struts, lateral and sway rods or angles; stringers, floor-beams and their connections; sizes of rivets; size, arrangement and character of floor system; and the class or classes of material proposed for use in the various parts of the structure.

The dead loads assumed for calculating the stresses shall not be less than the actual weight of the structure.

The plus (+) sign shall be used to indicate compression stresses and the minus (—) sign to indicate tension stresses.

Stresses shall be given in pounds, and weights of shape metal in pounds per foot of one piece.

The plans shall also include such detail drawings as are necessary to express the general intent of the whole work.

Shop Drawings.

4. The contractor shall not, except at his own risk, order any material until after the shop drawings have been approved by the engineer. After approval, the contractor shall furnish the engineer, without charge, as many sets of the shop drawings as he may require.

Drawings.

5. After the award of the contract, two complete sets of drawings and details, including stress sheet described above shall be furnished for approval, one set of approved drawings will be returned to the contractor and one will be retained by the Railway Company. One or more sets of drawings may also be required for the use of the inspector. These drawings shall in general be drawn to a scale of one inch to the foot.

Shop and Order Bills.

6. The contractor shall also furnish the engineer with duplicate copies of all shop and order bills of material and shipping lists of all finished parts, with exact itemized weights of same.

Size of Drawings.

7. All drawings shall be of uniform size twenty-four by thirty-six inches (24″ x 36″). They shall be numbered, arranged in systematic order and indexed.

Dimensions.

8. On all drawings, dimensions shown in figure shall govern in cases of discrepancy between scale and figures.

Contractor Responsible for Accuracy.

9. The contractor shall check all leading dimensions and clearances as a whole and in detail, the fitting of all details, and become responsible for the exact position and elevation of all parts of the work; and the approval of the working drawings by the engineer shall not relieve the contractor of this responsibility.

Variations.

10. In constructing the work, no variations at any time from the approved drawings, nor from these specifications, shall be made by the contractor, without a written order from the engineer in each case, describing and directing such change.

Notes.

11. Notes or specifications appearing on the engineer's general drawings are to be construed as superseding and voiding any clauses, or parts of clauses, in these specifications, with which they may conflict.

Rivets.

12. Rivets shall be indicated in accordance with the code shown in the appendix.

See Appendix B.

III. FLOOR.

Cross-ties.

13. Cross-ties shall be of the best quality of long leaf southern yellow pine, white or burr oak. They shall have a width of 8" and a depth depending upon the distance between centers of supports, as follows:

Spans.

Up to	8'-0"	c. to	c. Dimensions.	8"x 8"x10'-0"
	8'-0"	"	"	8"x 9"x10'-0"
	9'-0"	"	"	8"x10"x10'-0"
	10'-0"	"	"	8"x11"x12'-0"
	12'-0"	"	"	8"x12"x12'-0"

They shall be spaced 12" between centers, notched ½" over supports, and every fourth tie shall be fastened to the flanges of stringers by ¾" hook bolts flattened at their

lower ends to prevent turning. These bolts shall pass through the raising pieces when used, if practicable.

Ribbons.

14. There shall be an 8″x6″ ribbon, of the same material as the ties, on each side of each track, with its inner face parallel to and not less than 4′ 2″ from the center of the track and notched 1-½″ over each tie, when rails 5″ high are used. When rails of less height than 5″ are used, the ribbon shall be notched so that its upper surface shall be ½″ below the top of the rail, or a ribbon of less height may be used.

The ribbon shall be fastened to every fourth tie (using the ties secured to the stringers by hook bolts) by ⅝″ machine bolts, having a ⅛″ wrought washer on the top of the ribbon, and a ½″ cast washer under the tie. Ribbons shall be spliced over ties by halving horizontally with a lap of 6″ Each splice shall be secured by a ⅝″ bolt at center, the holes of the bolts being 11-16″ in diameter. The ribbons must be continued over all piers and abutments.

15. Hook bolts and ribbon bolts are considered to be a part of the metal superstructure. See paragraph 163.

16. The standard spacing for track stringers shall be 6′-6″ between centers, and the tracks will be 13′-0″ between centers unless otherwise ordered. In double track metal bridges with three trusses the clearance, length of cross ties and spacing of stringers for each track shall be the same as above specified for single track bridges.

Deck Bridges.

17. In single track metal bridges, if the width between centers of trusses does not exceed 12′ the cross ties may rest directly on the top chords. If of greater width, floor beams and track stringers shall be used. In plate girders having a span of 50′-0″ or less, the girders shall be 6′-6″ c. to c. and in longer spans 8′-0″ c. to c. All girders shall be thoroughly braced laterally and transversely.

Elevation of Outer Rail.

18. The outside rail shall be elevated as required by the engineer. This will be effected by wedge-shaped ties or

by raising pieces on supports as may be deemed best. If wedge-shaped ties are used, their depth at the inner support shall not be less than for bridges on tangent.

IV. LOADS.

Static Load.

19. The weights assumed for calculation shall be as follows: Rails and fastenings 100 lbs. per lineal foot of track. Timber per foot B. M., Oak, 4-½ lbs.; Yellow Pine, 4 lbs.; Wrought Iron, 3 1-3 lbs. per lineal foot for bar 1" square. Wrought Steel, 3.4 lbs. per lineal foot for bar 1" square. The dead load shall be assumed as concentrated 2-3 at panel points of loaded chord, and 1-3 at panel points of unloaded chord.

Moving Load.

20. The moving load shall, unless otherwise specified, be one of the loadings given in appendix, and specified on the second page hereof.

See Appendix C.

Impact.

21. The effect of impact and vibration shall be added to the maximum strains resulting from the live load, and shall be determined by the following formula:

$$I = L \frac{L}{L + D}$$

Where I = Impact.
L = Maximum live load stress.
D = Dead load stress.

The impact on floor beam hangers shall be assumed at 125%.

In computing the effect of impact in cases where the live load and dead load stresses are of opposite nature, the dead load stress shall be assumed to be zero.

Centrifugal Force.

22. Where the structure is on a curve, the effect of centrifugal force shall be considered and computed by the following formula:

$$C = \frac{W\ V\ 2}{32,\ 2,\ r.}$$

In which W = Live Load,
v = Velocity in feet per second,
r = Radius of curve in feet,

Note.—See Osborn's Tables for values of C for various velocities and degrees of Curvature.

Longitudinal Forces.

23. The longitudinal bracing in metal towers and the attachments of fixed ends of all girders shall be capable of resisting the momentum of train when brought to a sudden stop, the co-efficient of friction of wheels sliding upon rails, being assumed at 0.2.

Wind Forces.

24. The bottom lateral bracing in deck truss bridges and the top lateral bracing in through truss bridges shall be proportioned to resist a moving force of 150 lbs. per lineal foot for spans of 200 feet and under, and 0.4 lbs. per lineal foot for each additional foot in length over 200 feet.

25. The bottom lateral bracing in through truss bridges and the top lateral bracing in deck truss bridges shall be proportioned to resist a moving force of 450 lbs. per lineal foot for spans of 200 feet and under, and 0.4 lbs. per lineal foot for each additional foot in length over 200 feet.

26. The lateral bracing in plate girder bridges shall be proportioned to sustain a moving load of 330 lbs. per foot with 30 lbs. additional for each foot in depth of girder. Rigid cross frames shall be provided connecting the upper and lower flanges at intervals not exceeding fifteen feet, and all bracing shall be capable of transmitting compression as well as tension stresses. The lateral bracing in deck plate girder bridges will be placed in the plane of the upper flanges.

Trestles.

27. In trestle towers, the bracing and posts shall be proportioned to resist wind pressures in addition to the stresses from dead load, live load, centrifugal and traction forces, as follows:

1st. A force of 300 lbs. per lineal foot of structure applied 8′ above base of rail, and a wind pressure of 30 lbs. per sq. ft. on the exposed surfaces of all trusses, girders and towers.

2nd. A wind pressure of 50 lbs. per sq. ft. on the exposed surfaces of all trusses, girders and towers.

All trestle bracing shall preferably be composed of shapes designed to transmit compression as well as tension stresses.

Anchorage.

28. In determining anchorage for the loaded structure, the trains shall be assumed to weigh 800 lbs. per lineal foot.

Struts.

29. Lateral and longitudinal struts shall be proportioned to resist the resultant due to an initial stress of 10,000 lbs. per square inch upon all rods attached to them when this is in excess of wind stress.

Temperature Stresses.

30. Where the effect of a variation of 150 degrees F. is to produce stresses in the structure, the maximum of such stresses in each member shall be provided for.

V. UNIT STRESSES.

31. All parts of the structure shall be proportioned by the following unit stresses: (See paragraph 21.)

Tension

Wrought iron, 15,000 lbs. per square inch.

Soft steel, 17,000 lbs. per square inch.

Medium steel, 19,000 lbs. per square inch.

ompression.

32. Members with square bearings at both ends, $\dfrac{C}{1+\dfrac{l^2}{36{,}000\,r^2}}$ per sq. inch.

Members with square bearings at one end and pin bearings at the other, $\dfrac{C}{1+\dfrac{l^2}{24{,}000\,r^2}}$ per sq. inch.

Members with pin bearings at both ends, $\dfrac{C}{1+\dfrac{l^2}{18{,}000\ r^2}}$ per sq. inch.

In which C = 15,000 for wrought iron.
" C = 17,000 " soft steel.
" C = 19,000 " medium steel.
" l = length between supports in inches.
" r = least radius of gyration in inches.
l/r shall not exceed 100 for main members and
120 for subordinate members.

NOTE.—Values of $\frac{l^2}{r^2}$ may be taken from Osborn's Tables.

Bending. 33. Pins, closely packed, medium steel, 25,000 lbs. per square inch.

Bearing. 34. Pins..... .....24,000 lbs. per square inch.
Rivets..... ....22000 lbs. per square inch.

Shearing. 35. Pins, medium steel...12,000 lbs. per square inch.
Rivets..... 10,000 lbs. per square inch.
On webs of plate girders soft steel....10,000 lbs.
Medium steel....1,1000 lbs.

Field Rivets. 36. The number of rivets thus found shall be increased 20% for rivets driven in field.

Wind Stresses. 37. The same permissible stress shall also be used for members subject to wind stresses, centrifugal force and momentum of train. No allowance will be made for the wind stress when combined with stress from dead and live load, unless the combined stress exceed by 25 per cent. the stress from dead and live load only, in which case the combined stress will be used with a unit stress 25 per cent. greater than above given.

Alternate Stresses. 38. Members subject to alternate stresses of tension and compression in immediate succession, shall be so proportioned that the total sectional area is equal to the sum of the areas required for each stress. (See paragraph 21).

The strength of the connections shall be proportionately increased.

39. Members subjected to combined bending and direct stresses must be proportioned for the combined stresses. Combined Stress.

40. The timber parts of the structure shall be proportioned by the following unit stresses, given in pounds per square inch. Timber.

SPECIES	Transverse Loading.	End Bearing.	Short Columns l equal to or less than 12 d.	Bearing Across Fibre.	Shear Along Fibre
1. White Oak	1400	~~1400~~ 1300	1000	~~600~~ 550	300
2. Long Leaf Pine	1600	~~1600~~ 1300	1000	350	200
3. White Pine	~~1000~~ 1100	~~1000~~ 900	700	200	150

41. Columns whose length exceeds 12 times their least side shall be proportioned by the following formula: Timber Columns.

$$P = \frac{C}{1 + \frac{l^2}{1{,}000\ d^2}}$$

Where P= Unit load on column.

C= Unit load as given above for short columns.

l= Length of column between supports, in inches.

d= Least side of column, in inches.

VI. GENERAL DETAILS.

42. When the track is on a curve, both inner and outer trusses or girders are to be alike and to be figured for the proportion of the live load given by the formula: Track on Curve.

$$w = \frac{m + b}{2\,b} P$$

Where

W = load going to either trusses.

m = center ordinate to curve.

b = width c. to c. of trusses.

P = the live load at panel point considered.

Net Section.

43. The net section of any tension member or flange shall be determined by a plane, cutting the member square across at any point. The greatest number of rivet holes which can be cut by this plane, or come within an inch of it, are to be deducted from the gross section.

Pins and Rivets.

44. In deducting rivet holes to obtain the net section of riveted tension members, the rivet hole shall be taken with a diameter one-eighth (⅛) inch larger than the undriven rivet for rivets with full heads, and one-fourth (¼) inch larger for countersunk rivets in plates ⅝" or less in thickness.

Effective Diameter of Rivets.

45. The effective diameter of the driven rivet shall be assumed the same as its diameter before driving.

46. Where rivets are countersunk the bearing of the head shall not be counted.

Minimum Number of Rivets.

47. No connection shall be made with less than three (3) rivets.

Pitch of Rivets.

48. The pitch of rivets shall not exceed 6 inches, nor be less than three diameters of the rivet. At the ends of compression members the pitch shall not exceed four diameters of the rivet for a length equal to twice the depth of the member, and in the flanges of girders and chords carrying floor the pitch shall not exceed 4 inches.

Distance from Center of Rivet to Edge of Plate.

49. The distance from center of rivet to edge of plate shall not be less than 1-¼ inches, except in bars under 2-½ inches wide. When practicable it shall be at least two diameters of the rivet. It shall not exceed eight times the thickness of the plate.

Distance Between Rivets in Compression Members.

50. The distance between rivets for plates strained in compression shall not exceed sixteen times the thickness of plate in line of stress, nor forty times the thickness at right angles to line of stress.

Rollers.

51. All bridges exceeding 80 feet in length shall have hinged bolsters at each end and at one end nests of turned friction rollers of steel bearing upon planed surfaces. The rollers shall not be less than 4" in diameter, and the pres-

sure per lineal inch of roller shall not exceed 500 times the diameter of roller in inches. For bridges under 80 feet in length, one end shall be free to move upon planed surfaces.

Least Thickness of Plates.

52. No plate or shape shall be less than 3/8 inch thick for main members, or 5-16 inch thick for wind bracing, lattice bars, etc.

Length of Compression Members.

53. Compression members shall not exceed in length 40 times their least width nor 100 times the least radius of gyration for main members, and 120 times the least radius of gyration for subordinate members. "Main Members" shall include all elements of trusses, posts of towers or bents, and all other members directly acted upon by the live load. "Subordinate Members" shall include lateral systems, sway bracing, and all other members not directly acted upon by the live load.

54. The several segments or parts of a compression member shall be proportionately as strong as the member taken as a whole.

Stay Plates

55. Stay plates shall have a thickness of not less than one-fortieth (1-40) the unsupported width. They shall be not less than twelve (12) inches long, nor less than the greatest width of the member. "By length of stay plate is meant the dimension parallel to the axis of the member."

Lacing.

56. Lacing shall never make an angle of less than 60° with the axis of the member. If clear width between segments exceed 12 inches the member shall be double latticed, and the latticing shall never make an angle of less than 45° with the axis of the member.

Tension Members.

57. Long vertical tension members will preferably be stiffened.

Eye Bars.

58. Heads of eye bars shall be so proportioned as to develop the full strength of the bar. The heads shall be formed by upsetting and forging, and in no case will welding be allowed. (See paragraph 101.)

59. Eye bars must be perfectly straight before boring and bars working together shall be piled and clamped together and bored in one operation.

60. Eye bars shall not be less than five-eighths (⅝) inch thick, and preferably not less than one-fifth (1-5) the width of the bar.

Riveted Tension Members.

61. Riveted tension members shall have an excess of section of twenty-five (25) per cent. through pin holes and net section at all other points. Pin plates shall also be proportioned for bearing on pins. The material back of pins shall be proportioned for double shear, using for working length the distance from back of pin to end of plate. But the length of plate back of pin shall not be less than two and one-half (2½) inches.

Rods.

62. All rods with screw ends shall be upset at the ends so that the area at the root of the thread shall exceed by seventeen (17) per cent. the area of the rod.

63. All rods with welded heads must be of wrought iron.

Loop Eyes.

64. When loop eyes are used, the loop must be so designed as to develop the full strength of the bar.

The eyes must be reamed, and give full bearing on the pins.

Area of Rods.

65. No lateral or diagonal rod shall be less than one square inch in area.

Screw Ends

66. Screw threads shall be cut according to U. S. standard, except in ends of pins.

Washers and Nuts.

67. Washers and nuts shall have a uniform bearing. All nuts shall be easily accessible with a wrench for the purpose of adjustment, and shall be effectively checked after the final adjustment. All parts working together or parts of one member of the truss must be equally strained.

Bolts.

68. All bolts must be of neat length and have a washer under head and nut when they are in contact with wood. Washers and nuts shall have a uniform bearing. All nuts

shall be easily accessible with a wrench for the purpose of adjustment, and shall be effectively checked after the final adjustment.

Rivets shall be used in preference to bolts to resist shearing stresses.

When bolts are unavoidable they must be turned to a driving fit and have a washer under each and every nut. Bearing on threads will not be allowed.

Bolts with hexagonal nuts shall in general be used, and round-headed bolts will not be allowed.

69. All spaces which would otherwise permit the lodgment of water must be drained or filled with water-proof material. **Drainage.**

VII. I BEAMS.

70. I beams will be connected together in groups of two or three for each rail, have a ¾ inch sole plate and ¾ inch bed plate at each end, and be secured at each end to masonry by two 1″ anchor bolts, which shall enter the masonry at least 9 inches. Sheet lead ⅛ inch thick to be shipped, boxed, with girders and to be placed between bed plates and masonry. When ends rest on timber wall plates, the loose bed plate can be omitted.

71. When two or three "I" beams form a compound girder they will be connected together at intervals of about 3 feet, by means of vertical I beam separators riveted to their webs.

The standard width center to center of "I" girders will be 4 feet 11 inches and I beam separators will be not less than 20″ deep when two beams are used, and 10″ deep when three beams are used.

There will be a strut at each end, and a system of angle bracing between the girders.

VIII. PLATE GIRDERS.

Calculation.

72. The length of the span shall be considered as the distance between centers of end bearings, and the depth which shall preferably be not less than 1-10 of the span, shall be taken as the distance between centers of gravity of the flanges, unless this exceeds the depth from back to back of angles, in which case this latter depth shall be taken.

Flanges.

73. The compression flanges of plate girders and beams shall be made of the same gross section as the tension flanges, and they shall be stayed transversely when their length is more than twenty times their width.

Webs.

74. One-sixth of the web may only be considered as available gross area in each flange when the web sheet is not spliced. All joints shall be spliced by a plate on each side of the web and these plates shall have a double line of rivets on each side of the joint.

Stiffeners.

75. All web plates shall be stiffened at both edges of end bearings, and at all points of local concentrated loadings. Intermediate stiffeners shall be used if the ratio of unsupported depth of web to the thickness is greater than fifty.

76. Stiffeners shall be in pairs, and spaced so the shear per foot shall not exceed the safe shear given by the formula.

$$\frac{20000 \times 12\ t}{1 + \dfrac{d^2}{3000\ t^2}}$$

Where t = the thickness of web plate in inches

d = the clear distances between supports in inches.

NOTE.— See Osborn's Tables for safe resistance of web plate against buckling.

The maximum spacing of stiffeners shall not exceed six (6) feet.

77. There shall be at least two pair of stiffeners over the end bearings, the projecting legs of which shall be as wide

as flange angles will permit. These four stiffeners, including their fillers, shall take care of the maximum end shear.

78. Intermediate stiffeners shall not be less than given below:

For Webs 4 feet and under.....3½ x 3 x 5-16
For Webs 4 feet to 7 feet.....3½ x 3½ x ⅜
For Webs over 7 feet.....5 x 3½ x ⅜

79. Fillers, unless ruled otherwise for special cases, shall be placed under all stiffeners, the thickness being equal to the thickness of the flange angles. Fillers.

80. Six inch legs and over will in all cases be connected to the web plates by two rows of staggered rivets, the pitch of rivets shall not be less than 2-¼" nor more than 4-½".

81. Not less than one-half the total area of the flanges shall be concentrated in the angles, or the largest size angles shall be used.

82. Through plate girders or lattice girders shall be stayed by stiffened gussets at each floor beam or transverse strut.

83. Plate girders shall be cambered ¼" for each 25 feet in length, unless otherwise specified. Camber.

IX. STRINGERS AND FLOOR BEAMS.

84. Stringers shall generally be placed 6 feet 6 inches, center to center; shall be as deep as practicable, consistent with economy, and shall preferably be riveted to the webs of floor beams.

The span length shall be taken as the distance between centers of floor beams.

85. When lengths exceed 12 feet or twelve times flange widths, stringers will have their upper flanges connected by a system of angle bracing, angles to be not less than 3-½x3x5-16, with at least three ⅞ inch rivets in connection. Cross frames to be placed near outer ends of end stringers.

Bracing will be required in all cases where alignment is on curve.

86. Floorbeams will be riveted to the webs of plate girders or to the posts of through truss bridges, preferably above the pin in the latter case.

The span length shall be taken as the distance center to center of trusses.

Floorbeam hangers shall be avoided when possible. (See paragraph 21.)

87. All bridges shall preferably have end floorbeams and when distance from center of end floorbeams to back wall equals or exceeds 18", brackets shall be provided in line with stringers.

88. Connection angles of stringers to floorbeams and of floorbeams to truss, shall not be less than 3½x3½x9-16, and the webs of all stringers and floorbeams shall be faced true and square.

X. TRUSSES AND TOWERS.

Unsymmetrical Sections.

89. Unsymmetrical chord sections composed of two rolled or riveted channels and one plate shall be so proportioned that the centers of pins in abutting members shall be in the same line and the eccentricity may be made sufficient to counteract the bending stress due to the weight of the member or provision must be made for it, as in top chords and end posts. The material shall be concentrated mostly in the channels.

H—Sections.

90. H-shaped sections, if exceeding ten inches in depth, shall have tie plates at ends holding them truly square.

Top Laterals.

91. The top lateral struts shall be of the full depth of the chord and shall be securely riveted thereto. The top lateral rods, if used, shall be attached to the lateral gusset plates, which shall be securely riveted to the top chord.

92. For spans of 200 feet and under, each portal frame shall consist of four angles riveted to the end posts and connected by diagonal latticing. The latticing shall be flat bars if the depth of the portal does not exceed two feet and angles if of greater depth. **Portals**

For spans exceeding 200 feet in length the portal frames may consist of top and bottom struts connected by cross braces.

93. In through bridges, when the depth of truss is between 25 and 30 feet, knee braces shall be used at each vertical post; when the depth exceeds 30 feet sub-struts and overhead diagonal rods or lattice struts of angles shall be used at each vertical post. **Cross Bracing.**

94. There shall be built or cast steel bolsters at each end of span, securely anchored to the masonry, provision to be made for expansion. Anchor bolts shall be set in Portland cement. (See paragraph 163.) **Bolsters and Anchors.**

95. Long tension members shall be clamped together at intersection to prevent rattling. Posts and struts shall be in one length without splice. **Long Members.**

96. Struts composed of two channels latticed shall preferably have the webs of the channels vertical with the clear distance between webs such that the radius of gyration of the member with reference to an axis parallel to the webs of the channels shall not be less than the radius of gyration of the channels. Provision must be made for drainage where necessary. **Struts.**

97. The legs of trestle bents shall generally have a batter of one horizontal to six vertical.

98. The bents shall be united in pairs to form towers, and each tower thus formed shall be thoroughly braced in all directions. Lateral and longitudinal struts shall be provided at bottom and at each intermediate joint; also at top in the absence of floorbeams or girders acting as such. **Towers.**

99. Each leg shall be securely anchored to its pedestal, provision being made for expansion.

Chords.

100. If the length of the panel, divided by the least radius of gyration of the top chord is less than the length of span divided by the radius of gyration of the top chords, considered as a trussed column, the latter shall be used in finding the area of top chord sections.

Eyebars.

101. Eye bars shall be closely packed, and as nearly parallel as possible, the greatest allowable inclination of any bar being limited to 1 inch in 10 feet. (See paragraph 60.)

102. Screw ends of pins must project at least 1/4" beyond nuts, to permit upsetting in the field.

Camber.

103. Trusses shall have just sufficient camber to bring the joints of the compression chord to a true square bearing when the truss is fully loaded. Each member of the truss shall be lengthened or shortened in proportion to the street to which it is subject under a full dead and full live load, so that under the full loading each member will be strained to its normal length.

Eyebars and Pins.

104. The center of bearings of the stressed members are to be considered as the points of application of loads on pins when determining bending moments. The diameter of the pins shall not be less than 3/4 of the width of widest bar attached. Heads of eye bars must not be less in strength than body of bar.

XI. RIVETED WORK.

Soft Steel.

105. All holes in tension members of all thicknesses less than three-fourths (3/4) inch shall be either punched one-eighth (1/8) inch smaller than the rivet required and reamed to one-sixteenth (1-16) inch larger, or they may be drilled from the solid.

106. All holes in tension members of all thicknesses three-fourths (3/4) inch or greater shall be drilled from the solid.

107. All holes in compression members of all thicknesses less than three-fourths (3/4) inch shall be punched full size.

108. All holes in compression members of all thicknesses three-fourths (¾) inch or greater shall be drilled from the solid.

109. All holes in metal less than three-fourths (¾) inch thick shall be either punched one-eighth (⅛) inch smaller than the rivet required and reamed to one-sixteenth (1-16) inch larger, or they may be drilled from the solid. **Medium Steel.**

110. All holes in metal three-fourths (¾) inch or greater in thickness shall be drilled from the solid.

111. Reamed work is not required for fillers, lace bars, transverse, diagonal or lateral bracing, except to make holes true and square to members.

112. When plates are drilled as assembled, they must be separated after being drilled and cleaned of clippings forced between them by the drill. The square shoulders of all rivet holes under rivet heads must have a fillet of one-thirty-second (1-32) inch neatly removed.

113. Every built member or girder must be true and out of wind, neatly finished to length, and field driven rivets of all main girder connections shall be laid out with templates and accurately drilled, so as to pass the rivets cold.

114. Power riveting shall be used wherever possible. All rivets must have neatly capped full heads. Tightening loose rivets by recupping or "setting up" will not be allowed; they must be cut out and redriven, whether in shop or field. Rivets must be properly heated and driven to completely fill the holes. No loose rivets allowed.

See paragraph 68. **Bolts.**

XII. QUALITY OF MATERIAL.

A. WROUGHT IRON.

115. Wrought iron shall be made by the puddling process or rolled from fagots or piles made up from No. 1 wrought iron scrap, alone or with muck bar added. **Manufacture.**

Physical Properties.

116. The minimum physical qualities required shall be as follows:

Tensile strength, pounds per sq. inch.....48,000
Yield point, pounds per sq. inch.....25,000
Elongation, per cent. in 8 inches..... 20

117. In sections weighing less than 0.654 pounds per lineal foot the percentage of elongation required shall be 15 per cent.

Cold Bending Tests.

118. Cold bending tests shall be made on specimens cut from the bar as rolled. The specimen shall be bent through an angle of 180 degrees by a succession of light blows.

Nicking Test.

119. When nicked and bent, it shall show a generally fibrous fracture, free from course crystalline spots. Not over 10 per cent. of the fractured surface shall be granular.

Hot Bending Tests.

120. Hot bending tests shall be made on specimens cut from the bar as rolled. The specimens, heated to a bright red heat, shall be bent through an angle of 180 degrees by a succession of light blows and without hammering directly on the bend.

121. If desired, a bar shall be worked and welded in the ordinary manner without showing signs of red-shortness.

Yield Point.

122. The yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

Finish.

123. All wrought iron must be practically straight, smooth, free from cinder spots or injurious flaws, buckles, blisters or cracks. As the thickness of bars approaches the maximum that the rolls will produce the same perfection of finish will not be required as in thinner ones.

In flat and square bars one-thirty-second (1-32) inch variation either way from the size ordered will be allowed.

In round iron one one-hundredth (1-100) inch variation either way from the size ordered will be allowed.

B. CAST IRON.

124. Castings shall be of tough, gray iron, free from injurious cold shuts or blow holes, and of smooth, workmanlike finish.

One sample bar, one inch square, about five feet long, cast in sand mould, shall be furnished from each cast. This sample bar shall be capable of sustaining on a clear span of four and one-half (4½) feet, a central load of 500 pounds when tested in the rough bar.

C. WROUGHT STEEL.

Kind.

125. All steel shall be open hearth, made at works of established reputation, which have been successfully manufacturing steel for at least one year.

Acid Open Hearth.

126. If made in an acid furnace, the amount of phosphorous and sulphur in the finished product shall not exceed eight one-hundredths (.08) of one per cent. and six one-hundredths (.06) of one per cent., respectively.

Basic Open Hearth.

127. If made in a basic furnace, the amount of phosphorus or sulphur shall not exceed six one-hundredths (.06) of one per cent.

Test Pieces.

128. The tensile strength, elastic limit, elongation and reduction of area shall be determined from a standard test piece cut from the finished material and planed or turned parallel for at least ten (10) inches of its length, the piece to have as nearly one-half (½) square inch sectional area as practicable, and the elongation to be measured on an original length of eight (8) inches.

Specimens for bending tests shall be cut from the finished section and shall be of the same form as those used for tensile tests.

Number of Tests.

129. Three specimens, two for tensile tests and one for bending test, shall be furnished from each melt, except where a melt is rolled into widely varying sections, when each of such widely varying sections shall be represented by at least one test.

Where only a small portion of a melt is rolled into the order covered by these specifications, it is left to the discretion of the engineer or his authorized representative to reduce the number of tests.

If the manufacturer so desires, the bending tests may be made on the broken tensile test pieces instead of on specimens as specified above.

Full Size Test.

130. Eyebars shall be of medium steel. Full-sized tests shall show twelve and one-half (12½) per cent. elongation in fifteen feet of the body of the eyebar, and the tensile strength shall not be less than 55,000 pounds per square inch. Eyebars shall be required to break in the body, but should an eyebar break in the head, and show twelve and one-half (12½) per cent. elongation in fifteen feet and the tensile strength specified, it shall not be cause for rejection, provided that not more than one-third (1-3) of the total number of eyebars tested break in the head.

The engineer will notify the contractor of the number of full sized eyebar tests required.

All bars which do not meet the requirements of the specifications shall be at the expense of the contractor, all others shall be paid for by the purchaser, at the contract price of finished metal work on cars at shops, less the scrap value of the broken bars. (See paragraph 161.)

131. Material which is to be used without annealing or further treatment is to be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

Grades.

132. Steel shall be of three grades: Medium, soft and rivet.

Medium Steel.

133. Specimens from finished material, cut to size specified above, shall have an ultimate tensile strength of not less than 60,000 nor more than 70,000 pounds per square inch; and elastic limit of not less than 35,000 pounds per square inch, and an elongation of not less than twenty-two (22) per cent.

This grade of steel to bend cold 180 degrees over a mandrel, the diameter of which is equal to the thickness of the piece tested, without a crack or flaw on the outside of the bent portion.

134. Specimens from finished material, cut to size specified above, shall have an ultimate tensile strength of not less than 52,000 nor more than 62,000 pounds per square inch; and an elastic limit of not less than 32,000 per square inch; and an elongation of not less than twenty-five (25) per cent. **Soft Steel.**

This grade of steel must stand bending cold 180 degrees and close down flat on itself without sign of fracture on convex side of curve.

135. Specimens cut to size specified above shall have an ultimate tensile strength of not less than 50,000 nor more than 60,000 pounds per square inch; an elastic limit of not less than 30,000 pounds per square inch, and an elongation of not less than twenty-six (26) per cent. **Rivet Steel.**

136. All blooms, billets or slabs shall be examined for surface defects, flaws or blow holes before being rolled into the finished sections, and such chippings and alterations made as will insure solidity in the rolled sections. **Chippings and Alterations.**

137. Every finished piece of steel shall be stamped with the melt number, and steel for pins shall have the number stamped on the ends. Rivet and lacing steel, and small pieces for pin plates and stiffeners, may be shipped in bundles, securely wired together, with the melt number on a metal tag attached. **Branding.**

138. The chemical analysis for carbon, phosphorus and sulphur of each melt must be furnished to the engineer or his representative at the mill, before any of the material rolled from said melt is shipped from the mill. **Chemical Analysis.**

139. Finished material must present a smooth, clean surface, free from cracks, buckles, flaws, ragged edges, or any other defects, and must be straight throughout and true to section. **Finish.**

140. A variation of more than two and one-half (2½) per cent. from ordered weight will be considered cause for rejection. **Variation in Weight.**

For all plates ordered to gauge, there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in following table:

THICKNESS OF PLATE. Inch.	WIDTH OF PLATE.		
	Up to 75 inches. Per cent.	75 to 100 inches. Per cent.	Over 100 inches. Per cent.
¼	10	14	18
5-16	8	12	16
⅜	7	10	13
7-16	6	8	10
½	5	7	9
9-16	4½	6½	8½
⅝	4	6	8
Over ⅝	3½	5	6½

Shipments.

141. Shipments of material from the mills will not be permitted until after the tests have been made. Copies of all shipping invoices must be furnished to the engineer or his representative at the mill as shipments are made.

D. CAST STEEL.

142. Steel castings shall be made of a first class quality of open-hearth steel, sound, smooth, true to pattern, and free from blow holes, flaws and warps. All steel castings shall be thoroughly annealed at a temperature sufficiently high to make a blue scale, and when tested in three-quarter (¾) inch round turned test pieces, cut from castings, or from extensions cast to the castings, shall show an ultimate strength of from 65,000 to 75,000 pounds per square inch, and an elongation of not less than fifteen (15) per cent. in two (2) inches, and including the break.

E. PAINT.

Quality of Paint.

143. All paint for use in the "first coat" shall be of the best quality of graphite paint or of carbon primer, of a manufacture acceptable to the engineer.

144. All paint for use in the "finish coats" shall be of a quality and color specified on the second page hereof.

Inaccessible Surfaces.

145. All surfaces that are inaccessible after being riveted, or after erection, shall have, before assembling or before erection, two (2) coats of pure red lead and boiled linseed oil, mixed in the proportion of eighteen (18) lbs. of lead to one (1) gallon of oil.

All bolts which are to remain permanently in the structure are to be dipped in "first coat," as described above.

First Coat.

146. As soon as shop work is complete, the material shall be thoroughly cleaned from all scale, rust, grease or other foreign matter, and given one coat of "first coat," as described above.

Erection Marks.

147. Erection marks shall be made on the painted surface and not on the bare metal and then oiled over.

Retouching and Finish Coats.

148. After erection and before applying the finish coats, the material shall again be retouched and field rivets shall be painted with the "first coat," as described above; the field rivets shall be painted as soon as practicable after driving.

Finishing Coats.

149. All metal work shall, after erection, be thoroughly cleansed from mud, grease or any other objectionable material that may be found thereon (wire brushes or scrapers shall be used when necessary or required by the engineer), and painted with two (2) coats of "finish coat," as specified above.

No painting will be allowed in wet or freezing weather, and all surfaces must be dry when paint is applied.

Turned and Planed Surfaces.

150. All turned or planed surfaces shall be coated with a mixture of white lead and tallow before being exposed to the weather.

Copies of Orders.

151. All paint and oil used for the structure shall be especially purchased, and the contractor will furnish the engineer with copies of all orders for same; and until all

such copies have been received by the engineer, no paint shall be applied.

F. TIMBER.

152. All timber shall be of the best quality of the kind specified, cut from sound, live timber, free from loose or rotten knots, worm holes, wind shakes or splits, reasonably well seasoned, straight grained, square edged, and free from any defect calculated to impair its strength or durability. Sap wood shall not be allowed in more than ten (10) per cent. of the pieces of one kind, and no piece will be accepted showing sap covering more than one-fourth (¼) the width of the piece on any face at any point, nor more than half the thickness of any plank at its edge, at any point.

XIII. WORKMANSHIP.

153. All workmanship must be strictly first class.

154. All members that may become bent or in any way injured in transportation or erection, or from any cause, must be repaired, straightened and made good to the satisfaction of the engineer.

155. All plates and shapes shall be carefully straightened before the work is laid out, and all work must be finished in a neat and workmanlike manner. The edges of sheared steel plates in main members shall be carefully faced or planed to effectively remove defects caused by shearing.

Annealing.

156. No forging or other work must be performed on any material at a temperature as low as a blue heat, and all steel forged work must be afterward thoroughly and uniformly annealed by heating throughout to a uniform dark red heat and being allowed to cool slowly.

Appearance.

157. Due regard must be had for the neat and attractive appearance of the finished structure; and details of workmanship of an unsightly character will not be allowed.

XIV. INSPECTION AND TESTS.

Mill and Shop Inspection.

158. All material shall be subject to inspection and tests at mills and shops during the various processes of manufacture, and free access must be permitted for the Railway Company's engineer or inspectors at any works where material is in process of manufacture. A notice of at least one-week must be given to the Railway Company when its inspector may be on hand for the performance of his duties.

159. All materials and workmanship shall be subject to inspection and rejection of the Railway Company's engineer; and all materials condemned by him shall be immediately removed from the work.

Inspection not to Relieve Contractor.

160. The inspection of the work shall not relieve the contractor of his obligation to perform sound and reliable work, as herein provided. And all work of whatever kind which, during its progress, and before it is finally accepted may become damaged from any cause, shall be replaced by good, sound work, satisfactory to the Railway Company's engineer.

161. The contractor shall furnish the engineer or his inspector all necessary facilities for making the tests specified herein.

XV. ERECTION.

Erection.

162. The contractor shall erect the bridge complete, in a thoroughly workmanlike manner and ready for the ties, and to the lines and grades furnished by the Railway Company's engineer.

Anchor Bolts.

163. The contractor for superstructure shall furnish and put in place all stone bolts and anchors for attaching the iron or steel work to the masonry. He will drill all the necessary holes in the masonry and set all bolts in neat Portland cement of a brand satisfactory to the Railway Company's engineer. When the requirements of the contract demand that the bolts or anchors be built in the masonry the contractor for the superstructure shall furnish

said bolts and anchors and deliver them at the bridge site at such time as may be ordered by the Railway Company's engineer, but he will not be required to place them. (See paragraph 15.)

Lines, Grades, Etc.

164. All lines and grades are to be given by the Railway Company's engineer.

165. The stakes and marks given by the Railway Company's engineer must be carefully preserved by the contractor, who shall give the engineer all necessary assistance and facilities for the establishment of the lines and grades, and the measuring up of the work.

Unloading.

166. All material shall be unloaded at the bridge site with care and piled on skids well above the level of the ground.

False Work.

167. The contractor shall furnish and erect all false work, staging and scaffolding, and all tools and erection plant necessary to do the work thoroughly and expeditiously, and he shall remove the same as fast as the advance of the work will permit.

168. Before placing any false work, the contractor shall submit to the engineer for his approval, duplicate drawings, showing the location of all bents, and the placing of falsework other than such as is approved shall not be allowed.

Permits and Licenses.

169. The contractor shall give to the proper authorities all requisite notices relating to the work in his charge, and obtain all official permits and licenses for temporary obstructions, and pay all proper fees for same; and he shall pay for any other legal charges from city, town or county officers.

Damages.

170. The contractor shall pay all damages or losses or claims recovered that the owner may be made liable for, and save the owner harmless in all things from any accident which may happen or arise by reason of failure, neglect or refusal on his part or that of anyone in his employ to take all necessary precaution to prevent the same,

and also arising from any and all encroachments or trespassing on the neighboring property.

Refuse Material and Rubbish.

171. All refuse material and rubbish that may accumulate during the progress of the work shall be removed from time to time, and upon completion of the work all surplus material, falsework and rubbish shall be removed from the vicinity of the structure as may be directed by the Railway Company's engineer.

172. When the erection is done by the Railway Company, the contractor shall furnish all necessary pilot nuts for erection, to be returned to contractor in as good condition as when received, when erection is completed.

XVI. NAME PLATES.

173. Two name plates of suitable size and design, and which may be required to be of aluminum or bronze, shall be provided and securely fastened at points to be designated by the engineer. The plates shall be inscribed as directed by the engineer.

XVII. GENERAL.

174. The structure shall be built under the direction of the engineer in charge, in accordance with the general drawings, and will include all work of any description, whether specifically set forth herein or on the drawings, or not, to make the work herein provided for complete, to the entire satisfaction of the Railway Company.

Patented Devices.

175. All fees or royalties for any patented invention, article or arrangement that may be used upon or in any manner connected with the construction, erection of the work, or any part thereof, embraced in these specifications, shall be included in the price mentioned in the contract; and the contractor shall protect and hold harmless the Railway Company against any and all demands for such fees, royalties or claims, and before the final payment or settlement is made on account of the contract, the contractor must

furnish acceptable proof of a proper and satisfactory release from all such claims.

Subletting

176. No part of the work shall be sublet, nor shall the contract for the whole or any portion of the work be assigned unless by written consent of the Railway Company's engineer.

Employees.

177. Should any disorderly or incompetent person be employed upon the work, he shall upon notice from the Railway Company's engineer be discharged and not employed again without his permission.

Changes.

178. The work shall be done substantially in accordance with the accepted plans, details and directions by the engineer, and in accordance with these specifications, but the right is reserved by the Railway Company, without incurring any liability therefor, to make such changes in the said general or detail plans and in the specifications as its engineer may deem necessary for the convenience, safety and stability of the work, or as shall be deemed advisable or desirable by him, to make the same a satisfactory piece of work.

179. The right is also reserved by the Railway Company, without incurring any liability therefor, beyond the contract price, except as hereinafter provided, to increase or diminish the amount of labor or material, or both, herein provided for, within such limits as shall be deemed necessary by said engineer to make said work, when completed, a satisfactory piece of work.

180. But if any such change in any of the said general or detailed plans, or in the specifications, shall, in the opinion of the Railway Company's engineer, materially increase the actual cost of performing the labor necessary to construct the portions of the work thereby changed, beyond what such labor would have cost, if performed without such change, then the contractor shall receive the amount of such increased cost, as determined by the engineer, with ten (10) per cent. thereof additional, such percentage to be for and in lieu of profits; any decrease in such cost, as

determined by the engineer, shall inure to the benefit of the Railway Company.

181. And if by any such change in any of the said general or detail plans, or in these specifications, any material is used in the structure, the cost of which is, in the opinion of the Railway Company's engineer, in excess of that herein provided for, the contractor shall receive such excess of cost, as determined by the said engineer, and ten (10) per cent. thereof additional, such percentage to be for and in lieu of profits; any decrease of such cost, as determined by said engineer, shall inure to the benefit of the Railway Company.

Claims.

182. The contractor shall make no claim against the Railway Company for damages or losses occasioned by the elements or from any causes for which the Railway Company is not responsible. No claim for extra work not provided for in the plans and specifications will be allowed unless a written order to perform such work shall have been given by the Railway Company's engineer, and all claims for such work shall be presented in writing for settlement in the monthly estimate next after such work shall have been performed. Claims by the contractor for damages by reason of any detention on the part of the Railway Company will not be allowed, but any such detention shall make a corresponding extension of the time for completion of the contract.

Commencement of Work.

183. The work herein provided for shall be commenced upon any part or portion of the same, as the Railway Company's engineer may direct, within ten (10) days after receipt of written notice from the engineer so to do.

Prosecution of Work.

184. The work shall be prosecuted continuously and in the most energetic, expeditious and workmanlike manner, with the largest force of all classes of workmen that can be worked to advantage, and the contractor shall supply sufficient plant to work at such places and at as many places as the Railway Company's engineer may direct until the whole shall have been completed; or work upon any part or portion of the structure shall at any time be wholly or partially suspended or discontinued by order of the engineer, when-

ever in his opinion the best interests of the owner or the progress of the work upon other parts or portions of the structure may demand it.

Completion of Work.

185. The entire work herein provided for shall be prosecuted in such manner that the whole shall be complete and ready for acceptance by the Railway Company at or before the time specified on the first page hereof, or in the event that the contractor fail to complete the work within such specified time, he will be liable for any and all damage which the Railway Company may suffer in consequence of the delay; provided that any mutual agreement, set forth in the contract of which these specifications form a part, relating to damages for delay of completion after the specified time or to awards for completion before the specified time, shall be and remain in full force and effect.

186. If at any time during the progress of the work it should appear by the report of the engineer that the force employed, the quantity or quality of tools or appliances provided, or that the progress or character of the work or material furnished are not respectively such as, in the opinion of the engineer, will insure the completion of the work under this contract within the time specified, or not in accordance with the specifications, then in that case the Railway Company may serve written notice on the contractor and sureties to at once supply such increase of force, appliances or tools, and to cause such improvement to be made in the character of the work or materials, as will be required to make the same conform to these specifications and the requirements of the engineer; and if, on the expiration of three (3) days after the service of such written notice upon the contractor and sureties personally, or by leaving same or mailing same for them at last known addresses, the contractor shall have failed to furnish to the Railway Company satisfactory evidence of his efforts, ability and intentions to remedy the specified deficiencies, the Railway Company may thereupon enter and take possession of the said work or any part thereof, with tools, materials, plant, appliances, houses, machinery

and other appurtenances thereon, hold the same as security for any and all damage or liabilities that may arise by reason of the nonfulfillment of this contract within the time specified, and, furthermore, may employ the said tools and other appurtenances, materials, and such other means as it may deem proper to complete the work at the expense of the contractor, and may deduct the cost of the same from any payment then due or thereafter falling due to the contractor for this work; and, in case the contractor shall not complete the work within the time specified, and the Railway Company shall, notwithstanding such failure, permit the contractor to proceed with and complete the said work as if such time had not elapsed, said permission shall not be deemed a waiver in any respect by the Railway Company of any forfeiture or liability for damages or expenses thereby incurred, arising from such non-completion of said work within the specified time, but such liability shall continue in full force against the contractor and his sureties as if such permission had not been given.

Estimates and Payments.

187. Approximate estimates will be made monthly by the Railway Company's engineer if requested by the contractor, upon the amount of acceptable material delivered at the bridge site or erected in place, and also reasonable estimates will be allowed at the discretion of the engineer upon acceptable material delivered at the shops in reasonable amounts and proper condition.

Ninety (90) per cent. of the amounts of such estimates will be paid in cash within fifteen (15) days after approval of such estimates by the Railway Company provided no legal restraints are placed upon such owner preventing such payment. The remaining ten (10) per cent. will be paid within fifteen days after the final completion and acceptance by the Railway Company of all the work herein specified, provided the same is free from all claims for labor and material under these specifications, which might in any manner become a lien upon said structure or a claim upon the Railway Company.

Comply with All Laws.

188. The contractor shall be required to comply with all federal, state, city, town or other laws and statutes in force in

the locality, and it is understood and agreed that the contract of which these specifications are a part, is made and executed subject to the terms and conditions of any and all such laws. The contractor will be expected to inform himself regarding such laws, and to govern himself accordingly.

Special Clauses.

189. All the written part of these specifications and any special clauses attached hereto, and referring to this structure, are to be considered as a part hereof, and shall be as carefully noted and as strictly followed as if printed herein.

Plans and Specifications.

190. The plans and specifications are intended to be explanatory of each other, but should any discrepancy appear, or any misunderstanding arise as to the import of anything contained in either, the interpretation of the Railway Company's engineer shall be final and binding on the contractor; and all directions and explanations required, alluded to or necessary to complete any of the provisions of these specifications, and give them due effect, will be given by the engineer.

Engineer.

191. The term "engineer," as herein used, is understood to mean the chief engineer in charge of the work, and the work at all times shall be under his control, and the decisions of said engineer upon all questions as to estimates or the determination of the quantity or quality of the work, and on all other questions herein left to his discretion, shall be final and conclusive.

The above constitute the specifications referred to in the contract of the undersigned with

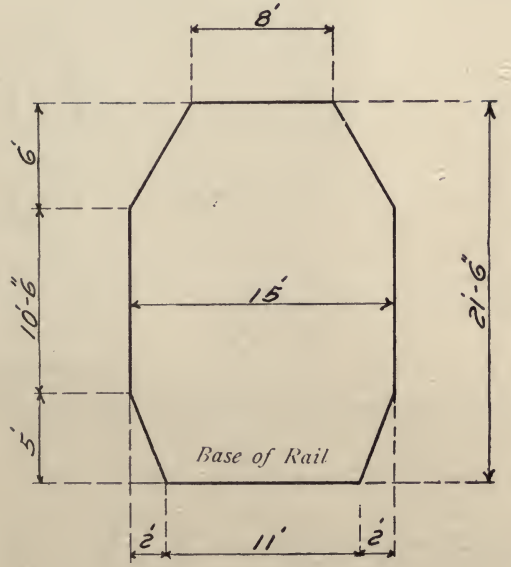
.....

dated .....

Contracting firm .....

By .....

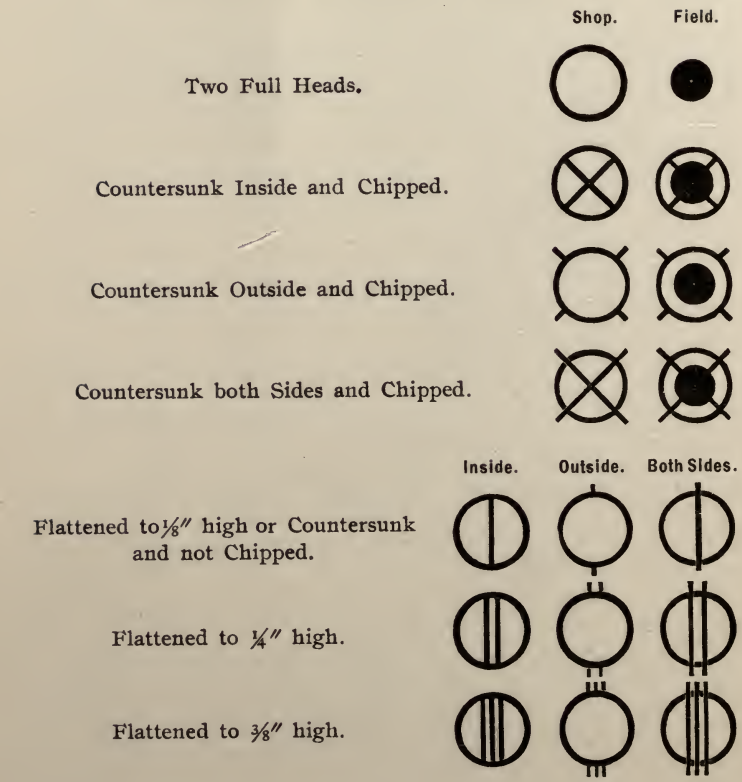
Appendix A.

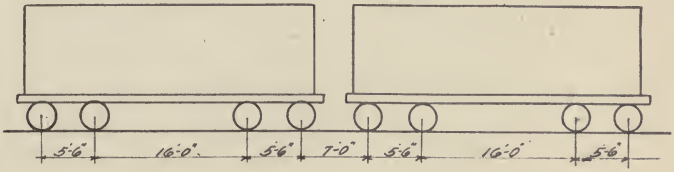


Clearance Diagram for
Through Bridges

Appendix B.

CONVENTIONAL SIGNS FOR BRIDGE RIVETS.

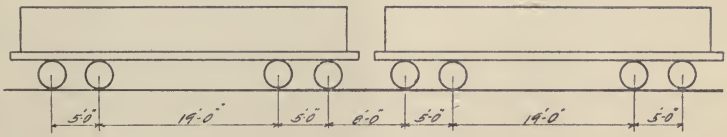




LIVE LOAD "A."

Train of 74 Ton Coal Cars.

Weight of Car = 38000 lbs.
Rated capacity = 100000 "
10% Overload = 10000 "
Total Load = 148000 "
Axle " = 37000 "



LIVE LOAD "B."

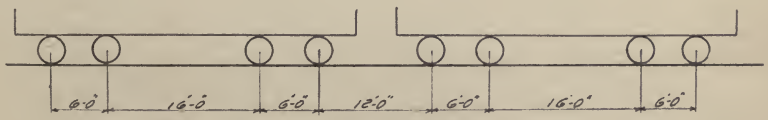
Train of 62 Ton Coal Cars

Weight of Car = 36000 lbs
Rated Capacity = 80000 "
10% Overload = 8000 "
Total Load = 124000 "
Axle " = 31000 "

LIVE LOAD "C."

Train of 46 Ton Flat Cars. - Same Wheel spacing as for 62 Ton Coal Cars

Weight of Car = 26000 lbs
Rated capacity = 60000 "
10% Overload = 6000 "
Total Load = 92000 "
Axle " = 23000 "



LIVE LOAD "D."

Train of 40 Ton motors.
Axle load = 20000 lbs.

Note. Live Load 'A' should be used for roads designed for heavy coal traffic etc.
Live Load 'B' . . . . . to carry occasional coal cars
" 'C' . . . . . ordinary freight
traffic, but not cars of over 60000 lbs capacity. This excludes coal traffic
Live Load 'D' should be used for roads designed to carry passenger and express traffic only.